Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

1.9
B524W

U. S. F. S. RECEIVED
LIBRARY
AUG 11 1937

United States Department of Agriculture
Bureau of Biological Survey

Wildlife Research and Management Leaflet BS-94

Washington, D. C. * July 1937

STATUS OF EELGRASS (ZOSTERA MARINA) ON THE NORTH ATLANTIC COAST, JANUARY 1937 /1

By John J. Lynch, Junior Biologist, and Clarence Cottam, Senior Biologist, In Charge Section of Food Habits, Division of Wildlife Research

---

Contents

	Page		Page
Introduction	1	Present conditions--Cont'd.	
Present conditions	3	Delmarva Peninsula	9
Maine and New Hampshire	3	Chesapeake Bay	10
Upper Massachusetts coast	5	North Carolina	11
Cape Cod and Buzzards Bay	5	Summary of conditions	12
Rhode Island south shore	6	Experimental plantings	12
Long Island Sound	7	Localities	13
Long Island south bays	7	Results	15
New Jersey	9		

INTRODUCTION

Since its almost complete disappearance in 1931, eelgrass (Zostera marina L.) has been making sporadic attempts to reestablish itself in many localities on the North Atlantic coast. Numerous small local growths have been reported; in all but a few areas, however, these have been short lived, and though apparently thriving for a time have been suddenly and almost completely wiped out by the causative factor responsible for the wasting disease of eelgrass.

1/ This report supplements and brings up to January 1937 the information on the condition of eelgrass, set forth in Leaflet BS-3, on "The Present Situation Regarding Eelgrass (Zostera marina)". Information on the history and extent of disappearance, effects of the disappearance, and past periods of scarcity is contained in the former paper.

This destruction of new beds of Zostera seems to occur generally from late in summer to midwinter, except possibly in the extreme southern part of its range, as in coastal North Carolina, where failure is often most in evidence from the middle of summer to early fall. New growths recorded early in the season, therefore, can hardly be considered indicative of recovery. The majority of the records included in this report have been verified to late December 1936 or early January 1937. Some of this rechecking was done by airplane, the extent and general features of the beds being noted, but the remainder of the plots were more closely inspected and the plants examined for evidences of disease. It may be pointed out that, observed from an airplane, there is usually a distinct difference noticeable in the general appearance of eelgrass from other submerged aquatics. It is significant and encouraging that at the time of this final check in all but two localities between Long Island and Maine the eelgrass beds were maintaining themselves, and several showed definite improvement. In most cases close inspection revealed that the rootstocks had vigorous growing tips and ample food storage, although the foliage was not heavy--a normal condition for that time of year.

Another encouraging feature that has become apparent in this season's work is the fact that Zostera frequently matures seeds in advance of the late-summer season of maximum disease activity. This is especially true in shallow brackish bays, as in the south-shore ponds of Rhode Island, and in some of the Long Island bays, where fruiting occurs in June. Seedling plants also were found in both these localities early in the summer of 1936. In more southern waters fruiting is proportionally earlier, and may be in evidence in March or April in Pamlico Sound, N. C. It should be stated, however, that fruiting is less common in the more southern parts of the range of the eelgrass, as new growth is there produced largely from the rootstocks.

Several places have been noted on the coast where new growths of Zostera show great progress near the mouths of fresh-water streams. One such growth at Plymouth Harbor, Mass., which is bathed in almost pure fresh water from Eel River at low tide, has progressed remarkably in the past season and has not shown any of the usual signs of disease, such as leaf-streaking or blotching. A similar situation prevails on a still larger scale among the eelgrass of Chesapeake Bay, where conditions have been almost normal for at least two years.

It must be understood, of course, that the present growths of eelgrass are not by any means comparable with those of normal years. In fact, in only two or three localities can the plant be said to have attained a growth of economic significance. In Bellport and Shinnecock Bays, Long Island, small flocks of brant and of the naturalized mute swan have been observed feeding over the beds of eelgrass, and broken fragments of the plants were noted drifting from the feeding place. As yet, however, northern beds showing recovery have failed to attract many of the brant during migration, as most of the birds apparently migrate directly to their wintering grounds near Atlantic City, N. J., or Pamlico Sound, N. C., stopping only in small numbers at their former Cape Cod and Long Island concentration points. The smaller total population of the brant (obviously reduced through loss of their eelgrass food) may in part also account for the facts noted.

By way of review it may be well to point out that eelgrass (Zostera marina) is a submerged pondweed (Naidaceae) growing on tidal mud flats and estuaries along the coast in water from the mean low tide level to a depth of 10 feet or more at low tide. Its range on the Atlantic coast is from Bogue Sound and New River in southern North Carolina northward to southern Labrador, with outlying more northerly stations in James Bay and southern Greenland. The same species likewise occurs on the European coast from the Mediterranean Sea northward to northern Scandinavia. This species with a number of varieties is found also on both the American and the Asiatic sides of the Pacific. It is significant that the plant is still unaffected in Pacific waters, while on both the American and the European sides of the Atlantic most of the eelgrass beds have been practically denuded since 1931.

Plants of Zostera from different localities on the Atlantic coast vary greatly in size and general appearance. Some of them along the coast of Maine may have leaves more than 2 yards long and half an inch wide. From Maine southward, the plants show an irregular, though none the less definite, reduction in size until in coastal North Carolina the leaves of some are only 5 or 6 inches long and proportionately narrow.

Preserved specimens of eelgrass group nicely on the basis of size into fairly distinct regional varieties. Further study shows that each region so indicated comprises a more or less definite coastal unit having quite similar ecological conditions. Preliminary study of older specimens in the Gray Herbarium at Cambridge tends to bear out the reality of this division of the range of Zostera into ecological units.

PRESENT CONDITIONS

Maine and New Hampshire

The coast of Maine and New Hampshire south to Great Bay is characterized by extreme ranges of tides, cool or cold water during a large part of the growing season, and a tremendous extent of shore line broken up into innumerable coves and bays. These bays are frequently shallow and have suitable bottom conditions for the growth of Zostera. The normal plant for that part of the coast is robust, the leaves often being 6 feet long. Probably a variety of ecological conditions contributes to the production of this large type of plant. The tendency of Zostera to expend its energies in vegetative activity as long as the water remains too cool to permit flowering may have some influence. In his monograph, Setchell 2/ concluded that vegetative growth would commence after the period of "recrudescent rigor" when the temperature of the water was 10° C, whereas flowering and fruiting could not take place until the water temperature registered between 15° and 25°.

The progress of one particular colony of eelgrass at the mouth of Great Bay, N. H., was followed rather closely this past season. When first observed in April the bed comprised fairly extensive stands of fine, healthy-appearing plants, these being quite solidly grouped in places. The

2/ Setchell, W. A. Morphological and Phenological Notes on Zostera marina L. Univ. Calif. Pub. Bot. 14: 389-452, f. 1-59. 1929.

largest leaves noted at the time were about 20 inches long. By July the beds had progressed remarkably, many of the leaves being more than 70 inches long. The rootstocks had become firmly matted, preventing a person from sinking in the soft muddy bottom, and the foliage was dense enough to make wading through the beds difficult.

Another check in August showed the plants to be holding up quite well, although the foliage had thinned out appreciably. This may represent a normal cessation of vegetative growth associated with the fruiting season, as seeds were maturing at the time. The leaves were rather badly streaked and blotched, however, and to determine whether the slump indicated the beginning of the end for this bed a final check was made in January 1937. The foliage then was much shorter than it had been throughout the summer, averaging less than 30 inches. This was to be expected, however, as eelgrass is not active during the winter. Otherwise the stand looked quite encouraging. Rootstocks were robust, with internodes as long as 2 1/2 inches. The season's growth of many rhizomes had amounted to as much as 15 inches. The same area had shown only a few isolated and more or less diseased plants two years earlier.

Northward in the Maine region a small area of scattered plants was discovered in July near York Beach. The leaves of these plants averaged about 30 inches long. Much smaller plants were located in August, in Casco Bay, near Falmouth Foreside. In that area the plants were found growing in beds of Ruppia. Drifting leaves noted on the bay at the time indicated that possibly there were more extensive beds in other parts of the area. Each year a few scattered plants have been produced in Casco Bay. All plants and leaves seen there during the past season were small for the region and were rather badly diseased.

Beds of eelgrass were reported from Jonesport, Maine, in August. Small fruiting plants were said to be common near Roque Bluffs, and much larger plants present in deeper water nearby. Other reports indicated that eelgrass was making some progress at Lubec early this season, and that small patches were thriving in Frenchmans Bay in places modified by fresh water.

The eelgrass parasite seems to be most active late in summer, a period coinciding with the warming up of the sea water. Since the water is cool over such a large part of the year in this region, one might expect that disease activity would be retarded. This is not borne out, however, by local reports. Numerous observers state that during the past three years eelgrass in many localities has produced apparently thriving growths only to be suddenly and completely wiped out by disease.

It is difficult to outline definitely the status of eelgrass for this region. The vast number of coves and bays on the Maine coast cannot be covered comprehensively by any such hasty survey as we have been able to make. If the few areas that were examined may be considered representative, however, small local growths of Zostera are surviving, suffering now and then from severe attacks of disease, but on the whole safely avoiding complete extirpation.

Upper Massachusetts Coast

The rocky character of the Maine coast gives way to a less broken shore line in southern New Hampshire and Massachusetts. A great part of this region consists of fairly shallow muddy and sandy bays and numerous tidal creeks, which provide ideal conditions for the growth of eelgrass. The typical eelgrass plants for this region are between 2 and 3 feet long.

Few evidences of the occurrence of Zostera on the Massachusetts coast from Duxbury northward were noted. One report from Newburyport says that a few small patches of eelgrass appeared in Plum Island Sound in the summer of 1935. Earlier reports from this same section have not been checked recently. On the other hand, a fairly extensive growth is thriving at the mouth of Eel River, in Plymouth Harbor. There the eelgrass reaches its greatest development where it has access to the fresh water from the river, the plants attaining a length of 25 inches. A scattering of plants, rarely exceeding 10 inches in length, extends out across the flats.

The rootstocks of eelgrass in this area show unusual growth for the season, having increased in length by as much as 14 inches within the year. This explains the noticeable spread of some of the beds since last spring. At no time this season was disease streaking found on the foliage of this colony.

Many patches of the eelgrass have been torn by clammers, and loose plants and clumps from these patches could be seen drifting about the flats throughout the summer. Many of these drift plants quickly settled into the mud in a new location and seem to be making a promising growth.

Cape Cod and Buzzards Bay

In the vicinity of Cape Cod and Buzzards Bay are numerous tidal and brackish ponds, and salt bays and creeks. The section is sandy and muddy throughout. No eelgrass was noted by the writers on the north and east shores of the cape during the past year, although small patches were reported from Barnstable Harbor early in the spring of 1936, and from Wellfleet Harbor and Nauset Inlet during the summer.

The salt ponds on the south shores of the cape and of Marthas Vineyard harbor small local growths of eelgrass. In Green Pond, near Falmouth, Zostera is scattered commonly through the Ruppia beds, in places forming rather rank, solid stands. The leaves average 18 inches long. The most recent foliage is quite free from disease markings, but indications from older growth point to a prolonged attack by the parasite during the summer. Rootstocks are often not robust, and dead portions with leaves still attached are not infrequent. The persistence of many leaf bases on the rhizomes may indicate abnormal leaf production stimulated by the disease. The shore drift, which was comparatively heavy all the past fall, would seem to bear out this hypothesis.

Green Pond, like other ponds in the section, is shallow and somewhat stagnant and, as a consequence, the water is likely to heat up rapidly

in summer. In this warm water the disease organism would probably find optimum conditions for growth and the growing season would spread over a long period of the summer months. In spite of this, however, eelgrass has certainly withstood the attacks in good shape and from present indications should continue to show progress.

Evidences of eelgrass were observed in Eel Pond and Waquoit Bay nearby, and a few small straggling clumps were found in Bass River last fall. In Waquoit Bay and possibly in some of the adjacent areas there has been a slight growth of Zostera during each of the past six years although much of that seen has been badly diseased. On Marthas Vineyard, Oyster Pond has had a fair growth of eelgrass for at least three years, and slight signs of growths were observed in Menemsha and Great Tisbury Ponds in November. Fishermen at Edgartown reported finding a few spears of eelgrass in their dredges in the spring of 1936. It was reported from Nantucket that the eelgrass was "beginning to catch in and show signs of coming back". Neil E. Stevens noted a few small patches of healthy-appearing plants in upper Buzzards Bay, in September (Plant Disease Reporter, October 1, 1936).

Rhode Island South Shore

Along the south shore of Rhode Island are many lagoons, which were formerly brackish, but are now kept open to salt water. The eelgrass plants there are of the typical shallow-bay form, tending to be quite small on the shoal flats and slightly larger in the channels. This may indicate that those on the shoals are young plants. Usually the eelgrass appears in a more or less straggling band in the sandy shallows that parallel the south beaches. During the annual waterfowl inventory of the Biological Survey in this section in January, observers in airplanes noted eelgrass beds that covered several acres.

The best growths occur in Charlestown Pond, where the eelgrass is found not only on the south beach flats but also on the north shore. The plants are about 20 inches long. The beds in this pond are generally more extensive and heavier than those in any of the other ponds along the south shore of Rhode Island. Quonochontaug has less extensive beds of small plants, which average less than 10 inches and are chiefly associated with Ruppia. Brightmans Pond has at least one bed of 20-inch eelgrass, and sporadic growths occur in Point Judith Pond near Matunuck. The age of these various stands is not definitely known.

In 1936, fruiting was finished in this region by the end of June, well in advance of the period of maximum disease damage. This was fortunate, as perpetuation of the growth is assured by the maturation of seed, even should the parent plants themselves be destroyed by disease. Seedling plants were found in Quonochontaug the past spring. General conditions in this section have been quite encouraging. The present growths have made definite progress during the season, despite the fact that one would expect severe disease activity in the superheated shallow water. The January aerial check revealed every bed that had previously been under observation.

Narragansett Bay, although it does not properly belong in the section here discussed, is included for convenience. The bay seems to be almost devoid of eelgrass, except for scattered plants reported in Newport Harbor and for one small patch seen in the Sakonnet River early this winter.

Long Island Sound

The Long Island Sound section, including Fishers Island Sound, extends from Watch Hill, R. I., westward along the Connecticut shore of the sound to New Haven. Much of the shore is cut by small rocky and gravelly coves, especially eastward, while a large part of the region westward comprises muddy and marshy bays and sandy beaches. Conditions of growth produce a type of eelgrass on this part of the coast that is quite different from that of nearby Rhode Island areas. Generally the Connecticut eelgrass is larger and has much longer leaves, probably owing to the deeper water, fairly strong tide, and fertile bottom.

Little Narragansett Bay has a fairly good growth of eelgrass, the beds occurring in the deeper water just off the sand flats of Napatree Beach. Many straggling plants are invading the higher flats. The leaves are fairly long, being more than 20 inches. Fruiting was quite heavy early in the summer of 1936. The most recent check made on the area--in December 1936--showed all the earlier beds still intact and individual plants relatively healthy. Quiambog and Mystic Coves, near Stonington, Conn., are typical small bays of the section. Large drifting leaves were observed in both areas in June, but the plants themselves were not found until December. The beds in Quiambog are small, but the plants are robust with heavy rootstocks that showed 8 to 10 inches of new growth. The winter foliage looked quite healthy. At the time this bed was observed, eelgrass was also found in Marshalls Cove nearby, on the shore of Long Island Sound.

In December several small patches of Zostera were noted growing in an area of about 10 acres in Niantic Bay. Plants there showed evidence of disease destruction during the summer. The present winter growth, however, was fairly free from disease streaking, and the rootstocks appeared healthy. Reports of eelgrass for localities west of Niantic Bay are infrequent. A small growth was reported from East Haven River early in the spring, and a few scattered plants were later observed in a tidal creek near Branford.

Long Island South Bays

The north shore of Long Island was not included in this survey; however, it has few suitable places for extensive eelgrass growths as compared with the south shore. In Great South Bay, which formerly had vast beds of eelgrass, there is now a fair new growth appearing on some of the flats. On Bellport flats beds of nearly a hundred acres were seen from the air early in January. The drift from these beds makes heavy windrows on the south beaches near Long Cove. Sporadic small beds and clumps were observed to the east of the heavier beds, nearly to Pattersquash Island. The plants of this entire eastern end of South Bay average 20 inches in length. Disease spotting was noted during the latter part of the season, and entire clumps of disease-killed plants could be seen in some localities. The fact that the beds are holding up so late in the season, however, is considered an encouraging sign that they will continue growth next spring.

Eelgrass is also thriving along the entire length of Fire Island Beach, from Bellport to Fire Island Inlet. This particular growth is composed of small patches averaging perhaps 5 feet in diameter. Only a few localities are entirely devoid of Zostera. In places the small patches are contiguous and form solid beds covering an acre or more. Probably the best growth in this section occurs off Cherry Grove. There the beds are well-matted, the rootstocks robust and regularly branching, and the leaves reach 15 inches in length. Another good stand grows near the Lone Hill Coast Guard Station, forming smaller beds, but the leaves reach 25 inches in length.

The rather sporadic growths at the Fire Islands seem not to have improved at all this summer. At present, small plants of Zostera are scattered through the Ruppia beds off West Fire Island, and small clumps are present on the East Island flats, especially toward the deeper water. Eelgrass is faced with a difficult problem of existence in this particular locality, as sand is drifted in over the beds by the heavy tides of Fire Island Inlet. On Oak Island flats, where a slight growth of Zostera occurs, the drifting sand does not seem seriously to affect the beds. At the Fire Islands, however, the accumulation of sand in places may be as deep as 5 or 6 inches, which is certainly detrimental to growing plants.

Shinnecock Bay has one of the best growths of eelgrass on the North Atlantic coast. The beds extend along the south shore of the bay, reaching their peak of development near the Tiana Beach causeway. Shallow-water plants average 15 inches in height, while those of deeper water may be fully 30 inches. Smaller beds also are found on the north shore, especially in Tiana Bay and in upper Shinnecock Bay, near the Peconic Canal. A thriving growth seen in Shinnecock Bay late in the spring was observed to have suffered somewhat of a slump toward early summer. Later in the summer and early in the fall, however, the eelgrass not only improved after this midseason ebb, but even surpassed earlier growths. Fruiting was quite heavy late in June, and seedling plants were found there at that time.

The rootstocks invariably have 6 or 7 persisting leaf bases on the growing end, indicating ample leaf production for the past season, and accounting for the heavy drift windrows of leaves on the shores of the bay. Whether this late vegetative growth was stimulated by disease damage to foliage is a question. At any rate, it was accompanied by a vigorous extension of rootstock systems, and this resulted in strengthening the beds and in some invasion of new territory.

Moriches and Peconic Bays were examined and no sign of eelgrass was noted. Only a few straggling plants have been seen in these bays during the past six years. Small patches were reported by fishermen on Jamaica and Hempstead Bays. Only blackened rootstock fragments, however, were found on Quantuck Bay and Ogden Pond, where members of the coast guard reported an encouraging growth last season. Mecox Bay contained small isolated plants scattered along the west shore and large (15-inch) plants in small patches to the south. A fair to moderate growth of eelgrass has occurred in this bay during each of the past five years. The growth cannot be stabilized, however, because of constantly changing ecological conditions caused by the repeated opening (some of it artificial) and closing of the inlet.

New Jersey

There is little eelgrass along the New Jersey coast. The rivers north of Barnegat Bay, notably the Shrewsbury, Shark, and Navesink, which formerly supported heavy growths of the plant, are now practically barren.

In Barnegat Bay, extensive reconnaissance revealed an insignificant stand of eelgrass. Slight drift on the bay shores south of Island Heights was traced to fairly large beds on the Island Beach flats south of Toms River. The plants there were largely mixed with Ruppia, pure stands being found in only a few localities in May. Since that time the beds have been blasted by disease. The rhizomes are spindling and entire small beds have been destroyed. The slight growth that a few viable rootstocks are putting out is so weak and thin that it resembles the type of eelgrass usually found in Chesapeake Bay and other southern waters. This bed of eelgrass, which was the best growth found along the New Jersey coast, is barely sustaining itself, and its condition at the present time cannot be considered very encouraging. In December a moderate quantity of drift was noted at one point about 10 miles south of Toms River, which may have come from some more vigorous bed of eelgrass in Barnegat Bay.

A few scattered living plants were seen on the outer beach near Lovelady, north of Beach Haven, and occasional drift leaves were observed on the west side of Little Egg Harbor opposite Beach Haven. Small growths of eelgrass have been reported from the latter place also in the past two years.

Two aerial surveys and numerous ground observations of the coast south of Barnegat Bay to Cape May failed to reveal any trace of Zostera, but one report of the plant occurring in Lakes Bay was received. Eelgrass was formerly abundant in much of this area.

Delmarva Peninsula

Insufficient investigations have been made along the coast of the Delmarva Peninsula to warrant a definite report. From the data available, however, it would seem fairly safe to say that there is practically no eelgrass north of the Maryland-Delaware State line and only an insignificant growth in the numerous coves and bays south of that point. A brief inspection of Sinepuxent Bay in May disclosed no beds of Zostera although a few drifting leaf blades were noted. Fishermen at that time and again early in December, however, reported a few small patches of the plant there, and in November and December it was said that a similar condition existed in Chincoteague Bay. Recently an observer is reported to have found a few plants near Popes Island. An incomplete inspection of the area by Lynch in November failed to disclose a single sign of Zostera on the Atlantic side of the Eastern Shore from Paramores Island southward to Cape Charles. No recent evidence of any return of the plant either in Isle of Wight or Assawoman Bays has been observed, although a detailed investigation has not been made. Most of the entire area was formerly covered with a dense growth of the plant. Since the abrupt wasting away of the eelgrass and the removal of the vegetative covering, wave erosion has been pronounced. Many areas have been sanded over and new channels have been formed. Fortunately for waterfowl and fish, as well as for

many other forms of marine life occurring in these bays, wigeongrass has begun to appear on many of the shoals formerly covered with Zostera and on a few of them it is already fairly abundant. This adaptable and widely distributed plant seems far more able to tolerate a sandy bottom than does eelgrass or most of the other pondweeds.

Chesapeake Bay

Chesapeake Bay is by no means a uniform body of water. Along the southern part, south of Pungoteague Creek, Va., is a sandy beach, which probably never had more than a few small patches of eelgrass or other submerged aquatic plants. Along the shore from Pungoteague Creek northward nearly to the mouth of Chester River, eelgrass apparently has long been abundant. North of Chester River to and including the famous Susquehanna Flats, the normal salinity of the water is below the tolerance of eelgrass. Slightly brackish and fresh-water plants are usually abundant throughout appropriate sections of this area.

When eelgrass began to disappear, it was noted that destruction was slowest and least complete in areas of reduced salinity. Furthermore, the first and best returns were noted in such places. It would seem then that the devastating organism is not tolerant of a low saline content and consequently is less effective in such an area. Because of the small area for run-off, but little fresh water enters the extensive coastal bays of the Delmarva Peninsula. This may be a partial explanation of why eelgrass has made little or no return in that area.

From personal inspection and from reports of other observers, it appears that in the southern part of the eelgrass zone of Chesapeake Bay, especially in the area from Pungoteague Creek, Va., northward at least to Crisfield, Md., the eelgrass suffered an unusually severe parasitic attack during the middle and latter half of the past summer. The quantity of drift was unusually large. The numerous leaf bases on surviving plants would seem to indicate severe loss and would account for the unusual extent of drift. It was encouraging to note from an inspection late in December that the surviving green leaves appeared comparatively healthy, although some of the characteristic brown or black blotches and streaks were in evidence on both the leaves and the rhizomes.

An inspection at Taylors Bridge, Md., in September and December revealed that conditions are still encouraging. Eelgrass, which was growing in water up to 6 feet deep, was abundant and fully 12 inches long. Most of the rhizomes appeared to be normal, although some spotting was noted and numerous bases of detached leaves were seen. A few plots were observed in which there were numerous dead rhizomes. The new growth seemed to be comparatively healthy.

A little farther south at Tarr Bay and Honga River, adjacent to Hoopers Island, where the salinity normally is higher, more dead roots were seen and the surviving plants were generally shorter, although near the Hooper River draw bridge some were found 18 inches long and of more than the average width for the southern variety of Zostera marina. Although there was evidence of much defoliation, all new growth seemed to

be doing well, showing only a minimum of disease. This would seem to presage a satisfactory growth for the summer of 1937. It was of interest to note, both in the Hooper Island area and at Taylors Bridge, a good growth of Ruppia maritima and Potamogeton pectinatus, and a fair stand of Zannichellia palustris in the same water with Zostera. Seven samples of water were collected at these areas in Dorchester County, Md., with the following relative percentage of sea salinity:

TABLE 1.--Salinity of seven samples of water collected in Dorchester County, Md.

No. of sample	Date	Locality	Average sea salinity
			Percent
1	July 25, 1935	Slaughter River, Taylors Island	32.61
2	------do-----	----------do----------	39.14
3	------do-----	At second draw bridge between Tarr Bay and Honga River-----	39.24
4	------do-----	Tarr Bay Marsh Pond----------	38.22
5	------do-----	Fishing Creek----------	39.71
6	Dec. 23, 1936	Taylors Island Bridge----------	40.18
7	------do-----	Tarr Bay, 1/4 mile from No. 2--	48.96

The p-H of all samples ranged from 7.5 to 7.8. It has been found that the minimum saline content that eelgrass is able to tolerate is slightly more than one-fourth the average of sea salinity.3/

Reports indicate that during the past year there has been no appreciable change in the eelgrass situation in the James, York, and Potomac Rivers, or in the other streams flowing into Chesapeake Bay. Some drift has been noted along the southern reaches of all these streams.

North Carolina

Inspection along the coast of North Carolina has not been so complete as desirable. Information obtained from both personal observation and reports indicates that the wasting disease was more than ordinarily severe in that area late last summer, resulting in an abnormal extent of drift when the relative scarcity of the plant is considered. Early in the summer a more encouraging crop of plants seemed to be in evidence. Disease was nevertheless noticeable in fully two of every three plants inspected. At Swanquarter scarcely a rhizome could be found that was alive more than 1 1/2 inches from a growing plant. Furthermore, all rhizomes and leafy parts of the plants were spindling. Few plants more than 5 inches long were noted and many were much shorter.

No appreciable change was detected in the condition of eelgrass in Bogue and Core Sounds during the past year. It is apparent that a small number of the beds are maintaining themselves although no noticeable recovery was detected. At the mouth of New River, N. C., it was surprising

3/ The average saline content of the sea is considered 3.5 percent total salts.

and most interesting to find both Ruppia maritima and Halodule wrightii growing in the same water with the dwarfed Zostera. This indicates a marked extension of the recorded northward range of the Halodule, which is the dominant species in at least a part of the New River area.

Information from Pamlico Sound reveals rather widely differing conditions. Eelgrass can now be found there in only a fraction of its former abundance. Many shoals where Zostera was formerly abundant are now shifting sands, and others are now covered with wigeongrass. More drift is noticeable in many places along the shore line than has been seen during any of the past six years. Some of this is of recent origin, as was noted in an inspection made during the last week of January, and appears to be relatively healthy. Fishermen and coastguardsmen report a large patch of eelgrass between Rodanthe and Oregon Inlet. A fair growth of rather spindling eelgrass that was coming into fruit was observed near Hatteras, yet all of it was diseased. In other areas where the plant was formerly abundant not a single specimen could be seen. On certain shoals near Ocracoke Island a slight improvement in the abundance and condition of the plants was reported.

Summary of Conditions

The wasting disease of eelgrass is still active along the entire Atlantic coast. From Long Island, N. Y., northward, however, there is encouraging progress toward the reestablishment of Zostera. On the whole, there are indications of a definite advance in the beds observed. New growth has more than offset the loss from disease. No evidence was found of any bed being completely destroyed by disease in the course of the season. Moreover, fruiting seemed to progress satisfactorily, a factor increasing the margin of safety of the eelgrass against future attacks of disease. It is not known whether a more resistant strain of the plant is developing, whether environmental conditions were unusually favorable during the past season, or whether the causative organism is becoming less virulent along that section of the coast.

No improvement was noted in the condition of the eelgrass along the coast of New Jersey and of the Delmarva Peninsula. Throughout that extensive section the plant is surprisingly rare and the prospects for its increase are not encouraging. New growths of Zostera are slow to appear, and the present beds are suffering badly from disease. In areas of reduced salinity, such as the Chesapeake Bay section, continued improvement is manifest.

But little change is noted from the conditions existing a year ago along the North Carolina coast. Because of its surprising and unparalleled rapidity of attack and because of its present baffling nature in affecting some areas and not others, this disease may be considered one of the most remarkable biological phenomena of recent times.

EXPERIMENTAL PLANTINGS

Because the eelgrass was almost extirpated from much of the Atlantic coast and because it has been found to be so highly important to bird life, fishes, and shellfishes, it was deemed advisable to make certain planting

experiments to see if the species could thus be reestablished. Inasmuch as the west-coast variety of Zostera is likewise of great importance and has escaped the blight, it was hoped that it could be transplanted to the denuded areas along the Atlantic coast. Accordingly, several bushels of both the narrow- and the broad-leaved varieties of Pacific eelgrass were obtained at Friday Harbor, Wash., and shipped east for experimental plantings. Plantings were made in 11 localities from Plymouth Harbor, Mass., to Cape Romain, S. C. Plants and seeds, obtained from the Pacific coast and from recovered areas on the east coast, were used.

The experimental plots were about 3 feet square, and usually were covered with poultry netting to protect them from waterfowl. Stakes at each corner of the plot served to anchor the netting, and at the same time acted as markers. The planting was done simply by pushing the rhizomes into the mud or sand. The foliage of the broad-leaved Pacific eelgrass was so long and rank that the leaves of many plants were cut off about 5 inches above the rhizome as a precaution against the uprooting of the plants by tides and wind currents.

Localities

Lakes Bay, Pleasantville, N. J.--Both the broad- and the narrow-leaved varieties of the Pacific eelgrass were planted here in separate plots on April 3, 1936. The plantings were made in fairly soft mud on the west side of the bay, near the Pleasantville High School. Both were covered with poultry netting. By May 10 the narrow-leaved plot was dying out and the rootstocks blackening. The plants of the broad-leaved variety were still intact at that time, the growing tips being fairly fresh. The older leaves were dying, however, and new leaves were very slow in coming. Subsequent checks of this planting, made early in the summer, revealed that the plants of both varieties had died out completely, leaving only dead rootstocks in the mud. Even these last remnants had disappeared by November 1936.

Manahawken, N. J.--One plot of the narrow-leaved variety of the Pacific eelgrass, planted in April under wire in Barnegat Bay south of the Beach Haven causeway, was not successful. A check on May 11 disclosed every plant in the plot dead, or nearly so, and the rootstocks blackened. Later observations failed to reveal any signs of revival.

Lewes, Del.--On October 24, 1935, Neil Hotchkiss and W. S. Bourn, both of the Biological Survey research staff, set out plants of the large Pacific coast form of eelgrass and sowed seeds at two localities along the Lewes-Rehoboth Canal near Lewes, Del., but no trace of the plants could be found when the place was revisited in April 1936. A single plot was set out in soft mud along the edge of the Lewes Canal on April 4, 1936, near the place where a similar planting had been made the previous season, and the bed was protected by wire. The plot was not revisited until December 1936, at which time no sign of the plant was apparent.

Rehoboth Beach, Rehoboth, Del.--A planting of the broad-leaved Pacific eelgrass was made here on April 4, 1936. The plot was located

in fairly firm sand in a salt pool off Indian River Bay, and was screened by wire. By May 16 the plants showed definite progress, having produced two or three new leaves and two new internodes of rootstocks. At that time, however, the pool appeared to be drying up. The plot was not seen again until December, at which time no sign of the eelgrass was evident.

Herring Creek, Berlin, Md.--The eelgrass planted in sandy mud on April 4 had largely disappeared by the middle of May, although a few surviving plants of the narrow-leaved Pacific type looked fairly good. Reports indicate that these died also later in the summer.

Wachapreague, Va.--Two plots of eelgrass were set out on the flats east of Paramores Island on April 5. These were not subsequently checked, but reports received do not suggest a successful result. On August 13, 1935, Hotchkiss collected about six bushels of the Chesapeake Bay plants near Wenona, Somerset County, Md., and transplanted them on the tidal flats near Wachapreague, Accomac County, Va. When the place was revisited no surviving plants could be found. On October 25, Hotchkiss and Bourn made two plantings of seeds of the west-coast Zostera and also two plantings of the rhizomes of the broad-leaved form at what would seem to be favorable places on the mud flats in the vicinity of Wachapreague. One planting was on the south side of Floyds Bay in 6 to 12 inches of water at low tide and the other at Cedar Island in about 1 foot of water at low tide. No plants could be found when inspections were made in April 1936. The Cedar Island plantings were later covered with a thick coating of sand.

Great South Bay, Long Island, N. Y.--Both the Pacific broad-leaved eelgrass and the Atlantic eelgrass from Chesapeake Bay were planted in the bay off Jones Beach Bird Sanctuary by Refuge Manager J. F. Herholdt. The Atlantic form, which had been collected at Pungoteague Creek, Harborton, Va., apparently failed completely to take hold, as did also two bushels of plants collected at Mecox Bay, L. I., in May. The Pacific form, on the other hand, was making some progress by May 6, although the algae that had collected on the screen over the bed had nearly smothered the plants. The wire was removed, and by June 6 all the plants seemed to be thriving and two had produced flowers and immature fruit. Early in August, however, this planting was found to have been almost completely wiped out by disease, hot weather, or some other factor, only two tiny spears being left of what had been a thriving growth. Whether this plot matured seeds before being killed is not known.

Newport, R. I.--On April 12, a plot of Pacific eelgrass was planted in Green Bridge Cove, and two smaller plots in Brentons Cove nearby. The Brentons Cove plants showed a little new growth by the first of May, and those in Green Bridge had produced new leaves 4 to 5 inches long. By June 10 the latter plot held fifteen healthy plants, one of them being in flower. Some of the leaves were 30 inches long, and all were absolutely free from blemish. In the interval between the inspection on June 10 and another observation made in August, however, every plant was wiped out and nothing but blackened rootstocks were left. The two smaller plots had never shown a very promising growth and finally died out altogether.

Plymouth Harbor, Mass.--On June 14 Pacific eelgrass was planted in the south end of Plymouth Harbor, near Eel River. By July 9 this planting had produced three flowering plants. All were quite stunted, however, none producing leaves more than 12 inches long. It is possible that the heavy growths of Ulva and Enteromorpha that covered the flats at this point interfered somewhat with the plants.

Marines, N. C.--Plants of the large Pacific coast form were set out on April 7, 1936, in New River, at Marines, Onslow County, N. C., among a growth of Ruppia and Halodule. They were set in about 1 foot of somewhat brackish water. No subsequent check has been made at this locality.

Cape Romain Refuge, S. C.--Eelgrass plants of the large Pacific coast form were set out by Hotchkiss on April 8 in about 1 foot of water in Mud Bay, Cape Romain Refuge, Charleston County, S. C. By May 3 this planting had been entirely destroyed by flood debris from the muddy Santee River.

Results

The experimental planting program met with no tangible success. Every effort to transplant Zostera, both from the Pacific coast and from other areas on the Atlantic seaboard, resulted eventually in failure, with the possible exception of the Plymouth Harbor planting, where a few plants may yet survive. The temporary success of some of the plantings, however, notably those in South Bay, Newport, and Plymouth, suggests that another attempt might be made to introduce the Pacific eelgrass in Atlantic waters. The fact that the plants introduced in the three localities mentioned produced flowers and immature fruit is somewhat encouraging.

The destruction of the eelgrass planted during these experiments may have been due to the same organism that has done so much damage to the Atlantic eelgrass. Specimens of diseased leaves from Pacific plants were submitted to C. E. Renn, of the Woods Hole Oceanographic Institute. He reports the presence in each of the west-coast specimens examined of Labyrinthula, which he and many others believe is the causative agent of the eelgrass disease.

In making plantings it seems that clipping of leaves is undesirable, as uncut plants progressed more rapidly and showed no tendency to be washed out with the tidal currents. This experience suggests that improvement can be made in future plantings.